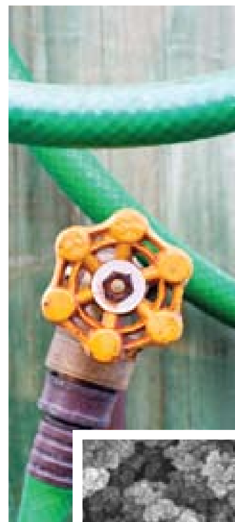
National Aeronautics and Space Administration

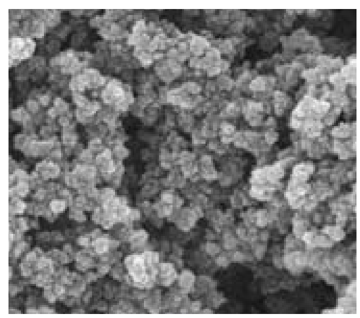
technology opportunity

Increased Flexibility for Polymer Cross-Linked Aerogels (X-Aerogels)

Significant improvement helps upgrade strength and elasticity

The use of flexible linking groups improves the strength of cross-linked aerogels.





SEM shows a mix of large and small pore sizes in a flexible cross-linked aerogel

A lower density sample compressed to 50% strain (center) has an initial length of 2.30 cm (left) and a 2.24 cm length after testing (right).

NASA's Glenn Research Center has enhanced its process for developing polymer cross-linked aerogels (X-Aerogels). Glenn previously was able to increase the strength without adversely affecting the porosity or low density by cross-linking silica and other oxide aerogels with a polymeric material. However, these aerogels still were subject to brittle failure. The improved process now provides flexible linking groups as part of the monolith structure, boosting the strength, elasticity, and resiliency of the aerogel.

Benefits

- **Better Elasticity**. Flexible linking groups improve the resilient nature of the aerogel.
- **Improved Resilience**. A more flexible monolith increases the integrity of the structure over time.
- **Increased Ruggedness**. Incorporation of flexible linking groups makes the aerogel easier to handle, prior to cross-linking.

Applications

- Thermal insulation for cryogenic propellant tanks
- Insulated shipping containers for transporting temperature-sensitive biomedical and pharmaceutical products
- Acoustic and vibration-damping materials
- Ballistic impact-absorbing materials
- Hose insulation
- Thermal pane skylights
- Catalytic supports
- Dielectrics for fast electronics
- Filtration membranes
- Fuel cell and battery membranes
- Optical sensors
- Aerospace components

Technology Details

How it works

Use of flexible linking groups in aerogels offers a significant advantage in improving strength in the aerogels by increasing elasticity and flexibility. Glenn researchers have shown that incorporating a flexible alkyl or alkylene oxide chain, capped with bis(trialkoxysilyl) groups into the underlying metal oxide of polymer cross-linked aerogels, provides a more resilient, flexible aerogel monolith. In the process of creating the aerogel, the flexible linking groups are included in the initial sol and co-react with tetraalkoxysilanes and other silanes used for cross-linking. The gel that forms from this process is washed and soaked in a monomer solution that reacts with the surface groups to form a conformal coating over the gel structure. Following this process, supercritical drying results in a more flexible, tougher aerogel monolith. The amounts of silica, flexible linking groups, and surface cross-links in the final monolith can be tailored to specific needs, resulting in custom density, superior toughness, and flexibility properties.

Why it is better

Researchers at Glenn developed several methods for improving their approach to enhancing X-Aerogels, which were already superior to the extreme fragility of traditional aerogels. Aerogels are ultra-lightweight glass foams with extremely small pores (on the order of 10–50 nanometers). These materials are extremely good thermal insulators, with R values ranging from two to ten times higher than polymer foams. Unlike multilayer insulation, aerogels do not require a high vacuum to maintain their low thermal conductivity and can function as good thermal insulators at ambient pressure. In addition, they are good electrical insulators and have low refractive indices—both approaching values close to air. Aerogels also are excellent vibration-damping materials. Glenn's new approach to sidestep the fragility and durability shortcomings of conventional aerogels makes them more desirable for both aerospace and commercial terrestrial applications. Despite these improvements, aerogels remained subject to brittle failure. By incorporating a flexible alkyl or alkylene oxide chain into the production, the new Glenn process further improves strength and toughness by adding to the monolith's overall elasticity and flexibility, making it more resilient. In addition, the incorporation of flexible linking groups before cross-linking makes the aerogel easier to handle, simplifying production of complex shapes or larger sizes.

Patents

NASA's Glenn Research Center and the Ohio Aerospace Institute have applied for patent protection for the Use Of Flexible Linking Groups In The Underlying Metal Oxide For Polymer Cross-Linked Aerogels.

Licensing and Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to inquire about the licensing possibilities for the Use Of Flexible Linking Groups In The Underlying Metal Oxide For Polymer Cross-Linked Aerogels (LEW-18265-1) for commercial applications.

For More Information

For more information about this and other technology licensing opportunities, please visit:

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